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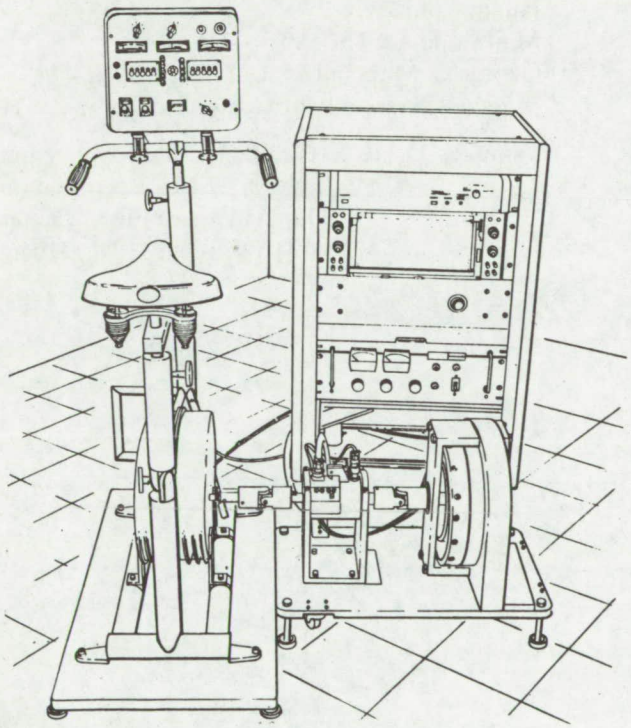
NASA TECH BRIEF

Marshall Space Flight Center

Multimode Ergometer System

A manually operable, multimode ergometer system overcomes previous ergometer design and calibration problems, such as inaccurate measurements; large weight, size, and input power requirements; poor heat dissipation; high flammability; and inaccurate calibration.



The system consists of (1) a lightweight, accurately controlled, multimode ergometer with low power requirements, low heat output, and minimal flammability problems; (2) a restraint system for securing the test subject while tests are performed under zero-G conditions or while the ergometer is not in the horizontal position; and (3) a calibration system with which the ergometer can be calibrated to within ±3.0 watts over a range of 25 to 30 watts.

The multimode ergometer includes a self-powered load module, a support frame, an electronic module, a control panel, a programmer, and an operator support device for hand-mode operation.

The load module consists of a lightweight metal housing containing a gear and pulley system, a dc torque motor (operated in the generator mode) a flywheel, a load cell, a speed pickup, and heat producing electronic components. A polyimide spur gear is meshed with a steel gear to reduce noise, weight, and flammability. A flywheel, bearing-mounted on the drive shaft, is gear-belt driven to produce a calculated inertia of approximately 2.16 kg-m^2 (1.48 slug-ft^2). The dc motor, in the generator mode, is a 14.9 joule (11 ft-lb) motor capable of an output of 350 watts. This output is used in conjunction with a force sensor to produce the system load.

The frame is of simple welded tube construction with adjustable, stowable handlebars and seat. The pedal configuration may either be stowed or used in the hand or foot mode of operation.

Control and display components are conveniently located for operator viewing and adjusting. A programmer provides for work load control in five protocol steps in which the heart rate per step can be selected over the range of 100 to 200 beats per minute, in increments of 10 beats per minute, and the time can be selected from 1 to 10 minutes, in increments of 1 minute. A switch provides for selecting either the EKG vest or the ear heart rate detection sensors. Provisions are made for automatic shutdown of the load at heartbeat rates of 160, 170, or 180 beats per minute. Program reset may be

(continued overleaf)

accomplished at any time, if desired, and work rate may be programmed by heart rate, or selected manually through the range of 25 to 300 watts.

Visual display of actual heart rate, pedal speed, actual work rate, and total work rate is provided.

The necessary electronics for programmer control and display are in solid-state modules for easier repair and lighter weight.

The restraint system consists of a form-fitting body belt, with suspenders, padded for comfort and as protection for EKG electrodes and conductors. It secures the operator firmly yet comfortably on the ergometer seat, without restricting body movement or blood circulation, and is easily donned and adjusted, essentially by one-hand operation.

A horizontal strap between the ends of the body belt temporarily secures the operator to the ergometer seat at zero-G conditions while the remaining equipment is secured and adjusted. The fastening devices secure easily, provide positive attachment to prevent failure under imposed working loads, and detach quickly for safety purposes.

The calibration system consists primarily of a 95.2 joule (70 ft-lb) torque motor and supporting frame, a power supply, a 110 joule (1000 in.-lb) torque sensor, a power computer, a multirange recorder, and a power controller.

A speed feedback system with an input for the ergometer maintains the calibrator motor at the desired speed over the operational torque range. Signals from the speed pickup and a slip-ring strain gage system in the torque sensor are fed to the power computer, where they are displayed as rpm and torque respectively. In addition, they are multiplied and displayed as watts and horsepower.

Notes:

1. The calibrator may be used to calibrate any type ergometer.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   Code A&TS-TU
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B71-10107

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Code A&TS-PAT
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

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(MFS-21044, 21045, 21046)